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島弧玄武岩マグマの含水量について：伊豆大島、三宅島、富士ならびに東北日本弧火山からの考察
On the Concentration of Water in Arc Basalts: case study in Izu Oshima, Miyakejima, Fuji and some perspectives

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Genesis, transportation mechanism and distribution of water in subduction system is very important to understand various geological phenomena in subduction zones. Origin of subduction zone magma is thought be deeply connected with dehydration of subducting slabs. Because water degassed from magma prior to or during volcanic eruption, concentration of water in arc magma is not well constrained. In this study, we show evidences that basalt magma in volcanic front generally contains several weight percent of water. This is in contrast with previous view on lateral variation of water in Japanese Quaternary volcanoes (Sakuyama, 1979; Aoki et al, 1981). It also contradicts with estimated geographical variation of fluid components in Japanese Quaternary volcanoes by Nakamura et al.(2008) and Nakamura & Iwamori (2010).

Based on high-pressure melting experiments on primitive basalt of Izu-Oshima volcano, Hamada & Fujii (2007) concluded that presence of 3 to 6 wt% of water is necessary in order to explain very calcic (˜An90) plagioclase phenocryst. Phase relation of primitive basalt from Ofunato stage of Miyakejima volcano has been studied experimentally (Ushioda et al, 2011) and it is found that about 3 wt% of water is necessary in order to explain its phenocryst assemblage (ol + pl) and the calcic plagioclase composition (An90-94). Moreover, Hamada et al. (2011) has established a new method to estimate pre-degassing water content of magma using hydrogen concentration in plagioclase phenocryst. Using this new technique, water content in main magma chamber of Izu-Oshima volcano prior to 1986 eruption was estimated be ˜5 wt%.

Presence of large amount of water in basalt magma is also supported from explosive volcanic eruption style of Fuji volcano (e.g. Hoei sub-plinian eruption of 1707). According to Machida (1977), amount of volcanic ash (tephra) from Fuji volcano may be equal or greater than its volcanic edifice. This indicates that the explosive erption style of Fuji volcano continued through time and therefore high water content in its basalt magma is a continuous feature.

Basalt magma is less abundant in the volcanoes on Honshu Arc due to the extensive fractionation, magma mixing and crustal melting. Precise estimate of water content in their primitive basalt magma is therefore difficult. However, presence of very high modal amount of plagioclase phenocryst in basalt and basaltic andesite (usually 30˜40 vol%), is a good indication of the presence of large amount of water in these mafic magmas. This is because, degassing of hydrous basalt at shallow magma chamber invariably accompanies crystallization of large amount of plagioclase(e.g., Hamada & Fujii, 2008).

We therefore propose that basalt magma in volcanic front of Izu Mariana Arc (e.g., Fuji, Izu-Oshima, Miyakejima) and those of North Honshu Arc are all wet, may be typically containing 5 wt% of water or even higher. This view strongly contradicts with previous works; 1) lateral variation of water content similar to potassium (Sakuyama, 1979; Aoki et al, 1981); 2) nearly anhydrous magma genesis model by Tatsumi et al.(1983) at the volcanic front, and 3) recent estimation of fluid component in magma based on systematics in Nd and Pb isotopes (e.g. Nakamura & Iwamori, 2010). Our model, however, is not inconsistent with a model proposed by Kimura et al.(2010). We will discuss origin of the discrepancy between our model and previous works. We will also emphasize the importance of the large water flux released by hydrous basalt magma at the volcanic front in considering circulation of water in subduction zone.

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